



DECLARATION

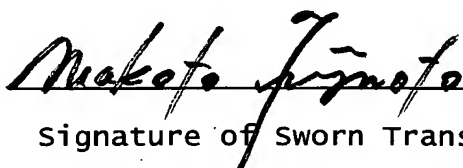
I, Makoto Fujimoto

being a translator of the Japanese and English languages, and
being in the employ of

NAEMURA & CO., of Tenjindaiichi Building 1006
2-26, Nishinakajima 4-chome, Yodogawa-ku
Osaka-shi, Osaka-fu, JAPAN

hereby certify that, to the best of my knowledge and belief, the
annexed document is a true, correct and complete translation of
Japanese Patent Application No. JP2003-028638 filed in the
Japanese Patent Office on 5 February 2003.

Signed at Osaka Japan, this 28th day of October 2005.


Signature of Sworn Translator



JAPAN PATENT OFFICE

This is to certify that the annexed is a true copy of the following application as filed with this office.

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| [Address] | Mr Shinichiro OOTA Commissioner, Patent Office |
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| [Inventor] | |
| [Domicile or Residence] | c/o Sumitomo Rubber Industries, Ltd. 6-9, wakinohama-cho 3-chome, Chuo-ku, Kobe-shi, Hyogo-ken |
| [Name] | Masanori YABU |
| [Applicant] | |
| [ID number] | 000183233 |
| [Name] | Sumitomo Rubber Industries, Ltd. |
| [Agent] | |
| [ID number] | 100082968 |
| [Patent Attorney] | |
| [Name] | Tadashi NAEMURA |
| [Telephone No.] | 06-6302-1177 |
| [Agent] | |
| [ID number] | 100104134 |
| [Patent Attorney] | |
| [Name] | Shintaro SUMITOMO |
| [Telephone No.] | 06-6302-1177 |
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| [Document name] | Specification 1 |
| [Document name] | Drawings 1 |
| [Document name] | Abstract 1 |

[Document name] Specification
[Title of Invention] Golf club head

[CLAIMS]

[Claim 1]

A hollow golf club head made of a metal material and having a head volume of not less than 440(mm³) characterized in that the golf club head is composed of a face portion for hitting a ball, and a head main body portion whose front edge is connected to the back face of the face portion and which defines a rear part of the club head,

a height of a club face which defines the front face of the above-mentioned face portion is 55 to 85(mm),

the area of the above-mentioned club face is 4000 to 6500 (mm²),

the ratio (Rf/Rh) of the face rigidity Rh defined by the

following expression ①, of a head main body front edge region

defined as extending a length of 10mm rearward of the club head

from the above-mentioned front edge of the above-mentioned head

main body portion, and the face rigidity Rf defined by the

following expression ②, of a face peripheral edge part which is

an annular zone being apart from the peripheral edge of the

above-mentioned club face towards the center of the club face by

not less than 3mm but not more than 15mm

is 4.0 to 12.0

$$Rh = Eh \cdot th^3 \dots \textcircled{1}$$

$$Rf = Ef \cdot tf^3 \dots \textcircled{2}$$

(wherein,

Eh is the Young's modulus of the head main body front edge region,

Ef is the Young's modulus of the face peripheral edge part,

th is the average thickness of the head main body front edge

region, and

t_f is the average thickness of the face peripheral edge part)

[Claim 2]

The golf club head as set forth in claim 1 characterized by a frequency of the primary local minimum of a frequency transfer function measured by a vibration method is 650 to 850 (Hz).

[Claim 3]

The golf club head as set forth in claim 1 or 2 characterized in that the above-mentioned face peripheral edge part is made of a metal material having a Young's modulus being smaller than or the same as the same metal material as the above-mentioned head main body front edge region.

[Claim 4]

The golf club head as set forth in any one of claims 1-3 characterized in that the above-mentioned head main body front edge region is made of a metal material whose Young's modulus is 8.0 to 9.0(GPa) and average thickness t_h is 0.7 to 1.2(mm), and the above-mentioned face peripheral edge part is made of a metal material whose Young's modulus is 6.8 to 7.5(GPa) and average thickness t_f is 1.6 to 2.2(mm).

[DETAILED DESCRIPTION OF THE INVENTION]

[0001]

[Technical Field of The invention]

The present invention relates to a large-sized golf club head capable of improving rebound performance.

[0002]

[Prior art and Problems to be solved by the Invention]

In recent years, it was found that, by setting the frequency of the primary local minimum of the mechanical impedance of a golf

club head closer to that of a golf ball, an energy loss at the time of hitting the ball is minimized and the coefficient of restitution is increased, and thus the flying distance of the struck ball is increased maximally. Such theory is usually, called "impedance matching theory", and already disclosed in the following patent documents 1 to 3 for example.

[0003]

[patent documents 1]

Patent publication No.2651565

[patent documents 2]

Patent publication No.2130519

[patent documents 3]

Patent publication No.1832305

[0004]

In general, the above-mentioned frequency of the golf balls is lower than that of the club heads. Therefore, in order improve the rebound performance by matching the impedances of the club head and golf ball, it is necessary to improve the club head to lower the above-mentioned frequency. As a technique therefor, an increasing of the head volume has been adopted.

The maximum weight of the club head is determined basically in view of swing balance. Accordingly, in order to increase the head volume, it is necessary to decrease the thickness of the club head in various portions to the utmost limit. This results in less rigidity of the club head and the above-mentioned frequency is reduced.

[0005]

However, from the results of various tests made, the present inventor discovered that when the head volume is increased to

over 440cm^3 in particular, contrary to expectation, the rebound performance can not be improved maximally only by the application of the impedance matching theory.

By the way, golf clubs having a head volume of over 440cm^3 are available in the market. Such club heads are mostly colorable products which are focused on only increasing of the head volume and can not be expected to have rebound performance improved up to a practical level.

[0006]

In view of the above-mentioned problems, the present invention was made, and an object is to provide a golf club head in which the rebound performance is improved maximally though the head volume is increased up to more than 440cm^3 .

[0007]

[Means of solving the Problems]

The invention as set forth in claim 1 is a hollow golf club head made of a metal material and having a head volume of not less than $440(\text{mm}^3)$ characterized in that

the golf club head is composed of a face portion for hitting a ball, and a head main body portion whose front edge is connected to the back face of the face portion and which defines a rear part of the club head,

a height of a club face which defines the front face of the above-mentioned face portion is 55 to 85(mm),

the area of the above-mentioned club face is 4000 to 6500 (mm^2),

the ratio (R_f/R_h) of the face rigidity R_h defined by the

following expression ①, of a head main body front edge region defined as extending a length of 10mm rearward of the club head from the above-mentioned front edge of the above-mentioned head

main body portion, and the face rigidity R_f defined by the following expression ②, of a face peripheral edge part which is an annular zone being apart from the peripheral edge of the above-mentioned club face towards the center of the club face by not less than 3mm but not more than 15mm is 4.0 to 12.0

$$R_h = E_h \cdot t_h^3 \dots \textcircled{1}$$

$$R_f = E_f \cdot t_f^3 \dots \textcircled{2}$$

(wherein,

E_h is the Young's modulus of the head main body front edge region, E_f is the Young's modulus of the face peripheral edge part, t_h is the average thickness of the head main body front edge region, and

t_f is the average thickness of the face peripheral edge part)

[0008]

The invention as set forth in claim 2 is the golf club head as set forth in claim 1 characterized by a frequency of the primary local minimum of a frequency transfer function measured by a vibration method is 650 to 850 (Hz).

[0009]

The invention as set forth in claim 3 is the golf club head as set forth in claim 1 or 2 characterized in that the above-mentioned face peripheral edge part is made of a metal material having a Young's modulus being smaller than or the same as the same metal material as the above-mentioned head main body front edge region.

[0010]

The invention as set forth in claim 4 is the golf club head as set forth in any one of claims 1-3 characterized in that the

above-mentioned head main body front edge region is made of a metal material whose Young's modulus of 8.0 to 9.0(GPa) and the average thickness th is 0.7 to 1.2(mm), and the above-mentioned face peripheral edge part is made of a metal material whose Young's modulus is 6.8 to 7.5(GPa) and the average thickness tf is 1.6 to 2.2(mm).

[0011]

[Embodiment]

An embodiment of the present invention will now be described in detail according to drawings.

Fig.1 is an overall perspective view of a golf club head 1 as an embodiment (hereinafter, sometimes referred to simply as "club head"). Fig.2 is an exploded perspective view thereof. Fig.3 is a front view of the club head. Fig.4(A) is a sectional view taken along line A-A in Fig.3, and Fig.4(B) is an enlarged view of B area thereof.

In the figures, the club head 1 is made up of a face portion 2 for hitting a ball, and a head main body portion 3 whose front edge 3E (shown in Fig.4(B)) is connected to the back face 2B of the face portion 2 and which forms a rear part pf the club head.

[0012]

The back face 2B of the above-mentioned face portion includes the physical back face 2B1 confronting the hollow i in the club head, and further a virtual back face 2B2 defined by an extension of the back face 2B1 to the outer surface of the club head for example as enlargedly shown in Fig.4(B).

The front edge 3E of the head main body portion 3 is a part connected to the virtual back face 2B2.

The expression "connected to" means either that the back face 2B

of the face portion 2 and the front edge 3E of the head main body portion 3 are fixed to each other by welding or the like, or that they are integrally formed by casting, press working or the like. In the club head 1 in this embodiment, as shown in Fig.2, the back face of a face member 2P formed as a plate is welded to the front edge 3E of a head main body portion member 3P having an opening on the front thereof.

[0013]

In this embodiment, the club head 1 is made of a metal material, and the above-mentioned hollow i is formed therein.

The hollow i is preferably remained as being void, but it may be filled with foamed resin as the need arises.

The club head 1 is formed to have a head volume of not less than 440cm^3 , preferably not less than 450cm^3 .

Such a large-sized club head becomes easy to use as the sweet spot area is increased and the directionality and flying distance can be improved.

Further, at the address position, the club head appears to be large. This will provide a golfer with a sense of ease.

However, if the head volume is too large, then the club head weight excessively increases, or the durability is liable to become insufficient as the thickness of each portion of the club head becomes very thin to avoid such a weight increase.

It should not be especially limited, but it is preferable that the upper limit for the head volume is not more than 650cm^3 , more preferably not more than 600cm^3 , still more preferably not more than 560cm^3 .

[0014]

The face portion 2 forms the club face F for contacting and

hitting a ball by its front face.

In the club face F, face lines and/or punch marks (not shown) are preferably provided.

The height H of the club face F is 50 to 85mm, preferably 55 to 65mm.

The area of the club face F is 4000 to 6500mm², preferably 4000 to 5500mm².

In a standard state in which the club head 1 is held at the predetermined lie angle θ and hook angle and the club head bottom face contacts with a horizontal plane HP as shown in Fig.3, the height H of the club face F is defined as a distance in the vertical direction between the highest point Pu and lowest point Pd of the peripheral edge E of the club face F.

The area of the club face F is the area of surface encircled by the peripheral edge E of the club face F, which is measured regarding the surface as even face devoid of depressed portion such as face lines and the like.

[0015]

The "peripheral edge" of the club face is the ridge line thereof if appeared clearly by visual observation. However, if the ridge line is unclear, the above-mentioned peripheral edge is defined as a line defining positions Ee at which the radius of curvature r of the profile line Lf of the outer surface of the club face becomes smaller than 200mm firstly when examined from the center of the club face F as shown in Fig.7(B), in each cross section of the club head cut along a large number of planes PE1, PE2 --- including a straight line extending between the center of gravity of the club head (not shown) and the sweet spot S as shown in Fig.7(A).

The peripheral edge E of the club face F is made up of a crown-side peripheral edge 2a, sole-side peripheral edge 2b, toe-side peripheral edge 2t and heel-side peripheral edge 2e.

[0016]

In the club head 1 according to the present invention, as the head volume is increased up to more than 440cm^3 , in order to improve the rebound performance and easiness of shot by utilizing this feature, it is necessary to provided the club face F having a proper size for the volume.

From this point of view, the club face F height H, club face F area and the like are determined.

More specifically, if the club face F height H is less than 55mm and/or the club face F area is less than 4000mm^2 , then the club face F becomes small in comparison with the head volume, and the rebound performance can not be fully improved.

If on the other hand, the club face F height H is more than 85mm and/or the club face F area is more than 6500mm^2 , then the club face F becomes too large in comparison with the head volume, which tends to works against the designing of the center of gravity of the club head and club head balance.

As shown in Fig.3, the width W of the club face F which is the horizontal distance between the most heel-side position Ph and the most toe-side position Pt of the club face F is for example 90 to 130mm, preferably 100 to 120mm.

This width W and the above-mentioned club face height H are measured by projecting on the vertical plane which is the basis for the lie angle.

[0017]

As shown in Fig.1, the head main body portion 3 in this

embodiment comprises a crown portion 3a defining the club head upper surface, a sole portion 3b defining the club head bottom face, a side portion 3c between the crown portion 3a and sole portion 3b, extending from the toe-side edge 2t of the club face F to the heel-side edge 2e of the face portion 2 through the back face, and a shaft inserting portion 3d protruding from the crown portion 3a on the heel-side.

The shaft inserting portion 3d has a circular shaft inserting hole h whose center line CL is substantially aligned with the axis of a club shaft (not shown) inserted therein. Accordingly, in order that the club head 1 is inclined at the lie angle, the center line CL is inclined at the lie angle while keeping the line within the vertical plane.

[0018]

In the club head 1 according to the present invention, as enlargedly shown in Fig.4(B), the ratio (R_f/R_h) of the face rigidity R_h of the head main body front edge region 4 defined as extending 10mm length rearwards of the club head from the above-mentioned front edge 3E of the head main body portion 3, and the face rigidity R_f of the face peripheral edge part 5 which is an annular zone being apart from the peripheral edge E of the club face F towards the center of the club face by not less than 3mm but not more than 15mm is limited to 4.0 to 12.0.

The face rigidity R_h , R_f is determined by the following expression①,②.

$$R_h = E_h \cdot t_h^3 \dots \textcircled{1}$$

$$R_f = E_f \cdot t_f^3 \dots \textcircled{2}$$

In the above expressions ① and ②, E_h is the Young's modulus (GPa) of the head main body front edge region 4, E_f is the Young's

modulus (GPa) of the face peripheral edge part 5, t_h is the average thickness (mm) of the head main body front edge region 4, and t_f is the average thickness (mm) of the face peripheral edge part 5. Here, the average thickness t_h , t_f is the area-weighted average thickness. For example, the average thickness t_h can be obtained by the following expression.

$$t_h = \sum (t_{hi} \cdot S_i) / \sum S_i \quad (i=1, 2, \dots)$$

wherein

t_{hi} is the thickness of each minute region i within the head main body front edge region, and

S_i is the area of the minute region i having the above-mentioned thickness t_{hi} .

[0019]

Fig.6(A) shows a plan view of the club head 1 under the standard state. Fig.6(B) shows a cross sectional view taken along C-C line of Fig.6(A) passing through the head main body front edge region 4.

The head main body front edge region 4 is a zone surrounding the above-mentioned hollow i . However, if this zone overlaps with the shaft inserting portion 3d on the heel-side, the head main body front edge region 4 should be defined by excluding this overlapped part. Specifically, as shown in Fig.6(B), an end $e1$ is defined at a position on the crown-side by excluding a cylindrical part of a radius $r_a=15\text{mm}$ from the center line CL of the shaft inserting hole h . And an end $e2$ on the sole-side is defined on the boundary of a tubular portion 7 formed in the club head. Therefore, in the example shown in Fig.6(B), the head main body front edge region 4 is defined by the region L extending from the crown-side end $e1$ to the sole-side end $e2$ through the

toe.

[0020]

The head main body front edge region 4 is subjected to a large compressive force at impact. The compressive force bends the head main body front edge region 4.

As shown in Fig.5, in fact, the head main body front edge region 4 continued like a belt can be regarded as a series of small braces divided by a unit width b . The above-mentioned compressive force generates a moment M_h to bend each brace B_h .

The bending rigidity of each brace B_h is obtained as the product $E_h \cdot I_h$ of the Young's modulus E_h and geometrical moment of inertia I_h of the brace. The face rigidity R_h of the head main body front edge region 4 is the average of the bending rigidity of the braces B_h . This is calculated by the above-mentioned expression① for the sake of convenience.

This face rigidity R_h can quantitatively specify the rigidity in the front and rear regions of the head main body, and by specifically defining this value, the deflection of the head main body front edge part 4 at impact can be controlled.

[0021]

Similarly, as the face peripheral edge part 5 is regarded as a series of small braces B_f divided by a unit width b , the bending rigidity of each brace B_f is obtained as the product $E_f \cdot I_f$ of the Young's modulus E_f and geometrical moment of inertia I_f of the brace. The face rigidity R_f of the face peripheral edge part 5 is the average of the bending rigidity of the braces B_f . This can be calculated by the above-mentioned expression② for the sake of convenience. By specifically defining this face rigidity R_f , the deflection of the face peripheral edge part 5 at impact can be

controlled.

Incidentally, I_h and I_f are proportional to the cube of the thickness t_h and t_f . ($I_f = b \cdot t_f^3/12$, $I_h = b \cdot t_h^3/12$)

Therefore, in the expressions ① and ②, I_h is replaced by t_h^3 , and I_f is replaced by t_f^3 .

[0022]

In the conventional club heads whose head volume is approximately 300cm^3 , the face rigidity ratio (R_f/R_h) usually has a large value of more than 12.0.

In the case of a club head having a large face rigidity ratio, the face rigidity R_f of the face peripheral edge part 4 becomes relatively large in comparison with the face rigidity R_h of the head main body front edge part 5.

From the results of tests made by the inventor, it was found that even if such face rigidity ratio is applied to large-sized club heads having a head volume of more than 440cm^3 just as it is, an effective improvement in the rebound performance can not be obtained from the impedance matching theory.

[0023]

The inventor analyzed deformations of club heads at impact, using super computer simulation. As a result, it was discovered that, in the case of the large-sized club heads, an internal energy loss of the club head becomes relatively large due to the deformation of the club head at impact, especially, part of the collision energy with a ball which stays on the club head as being vibration energy becomes large, and the energy loss becomes larger in the head main body front edge region 4.

The reason may be as follows. In a club head whose head volume and club face F area are large, by an effect of such shape, the

amount of deformation at impact becomes large. In the above-mentioned face rigidity balance, the energy loss concentrates on the head main body front edge region 4, and the above-mentioned vibration energy loss part excessively increases.

[0024]

The inventor repeatedly made structural analyses by changing the ratio of the face rigidity of the head main body front edge part 4 and the face rigidity of the face peripheral edge part 5, but keeping the club head weight and club face area constant.

As the central region of the face portion 2 contacts directly with a ball, it is necessary to provide rigidity on some level. In this test, a technique to change the above-mentioned rigidity of the face peripheral edge part 5 was employed.

If the ratio (R_f/R_h) of the face rigidity R_h of the head main body front edge region 4 and the face rigidity R_f of the face peripheral edge part 5 is limited to between 4.0 and 12.0, then the face rigidity ratio is optimized, and the energy loss at impact can be decreased to very small values.

[0025]

If the above-mentioned face rigidity ratio (R_f/R_h) is less than 4.0, then, in comparison with the face rigidity R_h of the head main body front edge part 5, the face rigidity R_f of the face peripheral edge part 5 becomes excessively small, and the rigidity of the face peripheral edge part becomes too decreased, therefore, the deformation of the club face F at impact becomes increased. Accordingly, a sufficient durability for the face portion 2 can not be obtained.

If more than 12.0, then, in comparison with the face rigidity R_f of the face peripheral edge part 4, the face rigidity R_h of the

head main body front edge part 5 becomes excessively small, and the deformation of the head main body front edge part 5 at impact becomes large, and the energy disappears as the vibration energy staying on the club head. Thus, an improvement in the coefficient of restitution can not be expected.

In particular, it is preferable that the above-mentioned face rigidity ratio (R_f/R_h) is set in a range of 4.0 to 10.0, more preferably 4.0 to 8.0.

The face rigidity R_h of the head main body front edge region 4 is preferably in a range of 4.0 to 10.0, more preferably 4.5 to 9.0.

If the face rigidity R_h is less than 4.0, then the residual vibration energy becomes too large, and the durability tends to become insufficient in the head main body front edge region.

On the other hand, if more than 12.0, then, in the case of a large-sized club head like in the present invention, the weight is increased in the head main body front edge region 4, and there is a tendency such that the flying distance decreases as the weight of the club head increases too much and a head speed is decreased, and the directional stability of the struck ball becomes worse as the depth of the center of gravity decreases.

Further, it is preferable that the face rigidity R_f of the face peripheral edge part 5 is set in a range of 40.0 to 70.0, more preferably 40.0 to 60.0. If the face rigidity R_f is less than 40.0, then the deformation of the club face F at impact becomes too large, and the durability tends to deteriorate. If more than 80, then the rigidity of the face peripheral edge part 5 becomes too high, and a sufficient improvement of the rebound performance based on the theory of impedance matching with ball can not be obtained.

[0026]

From the above-mentioned test, it was further discovered that it is especially preferable that the frequency of the primary local minimum of the frequency transfer function of the club head 1 measured by a vibration method is set in a range of 650 to 850 Hz. This responds to the above-mentioned frequency of the balls which is lowered in the recent tendency towards soft balls.

[0027]

The "frequency transfer function of the club head measured by a vibration method" referred to in this specification, can be obtained by the following expression when the club head is vibrated by a vibrator, using the acceleration α_1 at the vibrating point (fixing point of the vibrator to the club head) and the response acceleration α_2 .

Frequency transfer function

$$=(\text{power spectrum of } \alpha_1)/(\text{power spectrum of } \alpha_2)$$

[0028]

The above-mentioned "vibration method" is to measure the response of the club head caused by vibrations of a vibrator when the club head is fixed to the vibrator.

In this specification, the "vibration method" is defined as making the following measurement.

(1) Firstly, the club head is detached from the golf club shaft. (if the club head alone has been provided, this process is not necessary)

(2) As shown in Fig.8 and Fig.9, a vibrating member 12 (cylindrical, outer dia. 10mm) of the vibrator 13 is fixed to the sweet spot S of the club face F of the club head 1 by the use of an adhesive agent.

The reason to fix to the sweet spot S is to prevent the occurrence of moment due to eccentricity during vibrating.

Here, the sweet spot S is the point of intersection between the club face F and a normal line drawn to the club face F from the center of gravity of the club head.

However, for the sake of convenience, for example, it can be obtained as a point of balance at which the club head with the club face F down can stay on the upper end of a vertical tube of inside dia. 1.5mm and outside dia. 2.5mm, while achieving a balance.

(3) Using an adhesive agent, an acceleration pickup Pa2 is as shown in Fig.8 fixed to a suitable position on the club face F at which vibrations of the club head 1 can be measured (in this example, a position at 20mm from the sweet spot S towards the toe as shown in Fig.9).

(4) As shown in Fig.8, there is attached to an input jig15 an acceleration pickup Pa1 for measuring the acceleration at the vibrating point during the vibrator 13 vibrates the club head.

(5) As shown in Fig.10, applying vibrations to the club head 1 with the vibrator 13, a signal of acceleration α_1 of the input jig 15 and a signal of acceleration α_2 of the club head 1 are input into a FFT analyzer through a power unit.

(6) With the FFT analyzer, the frequency transfer function is determined (as power spectrum of α_1 /power spectrum of α_2).

(7) Fig.11 shows a measured result of the frequency transfer function. From such graph, there is read the frequency $F(\text{fix})$ of the primary local minimum (the lowest frequency in the frequencies of a plurality of local minimums) of the frequency

transfer function of the club head measured by the vibration method with the club head fixed to the vibrator.

[0029]

As an example of the above-described club head 1, it is preferable that the face peripheral edge part 5(or the face portion 2)is made form the same metal material as the head main body front edge region 5(or the head main body portion 3) or a metal material having a smaller Young's modulus.

More specifically, it is desirable that the head main body front edge part 4 is made of a metal material having a Young's modulus of 8.0 to 9.0(GPa), and the face peripheral edge part 5 is made form a metal material having a Young's modulus of 6.8 to 7.5(GPa).

[0030]

In this embodiment, the face portion 2 in which a titanium alloy Ti-15V-6Cr-4Al (Young's modulus:7.1GPa) is used is shown.

If the thickness t_c of the central region of the face portion 2 is too small, then due to the shock at the time of hitting a ball, damages of the face portion 2 e.g. cracks, dent and the like are liable to occur. Contrary, if too large, the rigidity is excessively increased and the rebound performance is deteriorated, and the flying distance tends to decrease.

It should not be especially limited, but it is preferable that the thickness t_c is set in a range of 2.0 to 3.5mm for example, more preferably 2.5 to 3.0mm.

The thickness of the face peripheral edge part 5 is determined to be less than the above-mentioned central region and to satisfy the above-mentioned face rigidity ratio.

Usually, the above-mentioned average thickness t_f is preferably set in a range of 1.6 to 2.2mm in view of a balance with the

strength.

[0031]

In the head main body portion 3, a titanium alloy Ti-6Al-4V(Young's modulus:8.6GPa) is used. In this example, one integrally formed by lost wax precision casting or the like is shown. The thickness and the like of the head main body front edge region 4 can be determined in variously ways to satisfy the above-mentioned face rigidity ratio. But, in view of a balance with the strength, it is preferable that the average thickness th is set in a range of 1.6 to 2.2(mm).

[0032]

As to the thickness of the head main body portion 3 in other than those above, there is no limit in particular as far as it has a practical strength. Thus, various values can be used. For example, it is preferable that the crown portion 3a is 0.5 to 0.9mm more preferably 0.6 to 0.75mm, the sole portion 3b is 0.5 to 1.5mm, and the side portion 3c is 0.5 to 1.2mm.

[0033]

[Embodiment]

According to the specifications in Table 1, wood-type golf club heads were experimentally made and their performances were compared by measuring the coefficient of restitution, durability and the like. As shown in Fig.2, each club head was made by welding a face member and a head main body portion member. The thicknesses of the various portions common to all club heads are as follows.

Thickness of the central region of the face member: 2.7mm

Thickness of the crown portion:0.7mm

Thickness of the sole portion:1.0mm

Thickness of the side portion:0.7mm

Testing methods are as follows.

[0034]

<Coefficient of restitution of Club head>

It was measured according to U.S.G.A. Procedure for measuring the Velocity Ratio of a Club Head for Conformance to Rule 4-1e, Revision 2 (February 8, 1999). A larger value is better.

[0035]

<Durability>

46 inches wood-type golf clubs were experimentally made by attaching identical FRP shafts to the test club heads. The club was mounted on a swing robot. The head speed was adjusted to 50m/s. Each club hit golf balls (Sumitomo rubber Ind., Ltd. "DDH EXTRA SOFT"(Registered trademark of said corporation) 3000 times. The club face was visually inspected for cracks. If there was no crack, the amount of dent caused in the club face was measured, and the value of the amount of dent was treated as results. A smaller value is better.

The test results and others are shown in Table 1. The relationship between the coefficient of restitution and face rigidity ratio is shown in Fig.12. The relationship between the coefficient of restitution and the primary frequency is shown in Fig.13.

[0036]

Table 1

| | Head volume (cm ³) | Face peripheral edge part | | | | Head main body front edge region | | | | Test Results | | | |
|-------|--------------------------------|---------------------------|-----------------------|---------------------------|------------------|----------------------------------|-----------------------|---------------------------|------------------|---------------------------|----------------------------|------------------------|-----------------|
| | | Material * | Young's modulus (Gpa) | Average thickness th (mm) | Face rigidity Rf | Material | Young's modulus (Gpa) | Average thickness th (mm) | Face rigidity Rh | Face rigidity ratio Rf/Rh | Coefficient of Restitution | Primary frequency (Hz) | Durability (mm) |
| Ex.1 | 450 | DAT55G | 7.05 | 2.00 | 56.40 | 6-4Ti | 8.60 | 0.90 | 6.27 | 9.0 | 0.878 | 870 | 0.03 |
| Ex.2 | 450 | DAT55G | 7.05 | 1.80 | 41.12 | 6-4Ti | 8.60 | 0.80 | 4.40 | 9.3 | 0.881 | 841 | 0.05 |
| Ex.3 | 480 | DAT55G | 7.05 | 1.80 | 41.12 | 6-4Ti | 8.60 | 0.80 | 4.40 | 9.3 | 0.883 | 816 | 0.08 |
| Ex.4 | 500 | DAT55G | 7.05 | 1.80 | 41.12 | 6-4Ti | 8.60 | 1.00 | 8.60 | 4.8 | 0.886 | 792 | 0.09 |
| Ex.5 | 550 | DAT55G | 7.05 | 1.80 | 41.12 | 6-4Ti | 8.60 | 1.00 | 8.60 | 4.8 | 0.886 | 721 | 0.10 |
| Ex.6 | 600 | DAT55G | 7.05 | 1.80 | 41.12 | 6-4Ti | 8.60 | 1.00 | 8.60 | 4.8 | 0.879 | 675 | 0.10 |
| Ref.1 | 450 | DAT55G | 7.05 | 2.00 | 56.40 | 6-4Ti | 8.60 | 0.70 | 2.95 | 19.1 | 0.863 | 870 | 0.10 |
| Ref.2 | 450 | DAT55G | 7.05 | 2.00 | 56.40 | 6-4Ti | 8.60 | 0.75 | 3.63 | 15.6 | 0.864 | 865 | 0.04 |
| Ref.3 | 450 | DAT55G | 7.05 | 1.80 | 41.12 | 6-4Ti | 8.60 | 0.70 | 2.95 | 13.9 | 0.866 | 840 | 0.11 |
| Ref.4 | 450 | SP700 | 9.30 | 1.80 | 54.24 | 6-4Ti | 8.60 | 0.80 | 4.40 | 12.3 | 0.858 | 920 | 0.10 |
| Ref.5 | 450 | 6-4Ti | 9.70 | 1.80 | 56.57 | 6-4Ti | 8.60 | 0.80 | 4.40 | 12.9 | 0.852 | 980 | 0.03 |
| Ref.6 | 450 | DAT55G | 7.05 | 1.80 | 41.12 | 6-4Ti | 8.60 | 0.70 | 2.95 | 13.9 | 0.871 | 590 | 0.35 |
| Ref.7 | 450 | DAT55G | 7.05 | 1.60 | 28.88 | 6-4Ti | 8.60 | 1.00 | 8.60 | 3.4 | 0.871 | 595 | broken |
| Ref.8 | 450 | DAT55G | 7.05 | 1.50 | 23.79 | 6-4Ti | 8.60 | 0.90 | 6.27 | 3.8 | 0.874 | 563 | broken |
| Ex.7 | 450 | DAT55G | 7.05 | 2.00 | 56.40 | 6-4Ti | 8.60 | 1.00 | 8.60 | 6.6 | 0.886 | 892 | 0.02 |
| Ex.8 | 450 | DAT55G | 7.05 | 1.90 | 48.36 | 6-4Ti | 8.60 | 0.80 | 4.40 | 11.0 | 0.878 | 871 | 0.02 |

* DAT55G: a titanium alloy Ti-15V-6Cr-4Al manufactured by Daido Steel Co., Ltd.

6-4Ti: Ti-6Al-4V, SP700: Ti-4.5Al-3V-2Mo-2Fe

[0037]

From the test results, it can be seen that the embodiments are larger in the coefficient of restitution when compared with comparative examples. Also, it was confirmed that the embodiments are possessed of sufficient performance regarding the durability. As to the club heads having the primary frequency of less than 850Hz, it was confirmed that the coefficient of restitution was increased.

[0038]

[Effects of the Invention]

As described above, in the golf club head according to the present invention, as the ratio of the face rigidity of the face peripheral edge part and the face rigidity of the head main body front edge region is defined, the rebound performance can be improved, while increasing the size of the club head, in order to increase the flying distance.

[0039]

As in the invention of claim 2, when the frequency of the primary local minimum of the frequency transfer function measured by a vibration method is set in a range of 650 to 850(Hz), the coefficient of restitution can be further increased to improve the flying distance.

[0040]

As in the invention of claim 3 or 4, the Young's modulus, thickness and the like of the above-mentioned face peripheral edge part and/or head main body front edge region can be defined in order to produce the club head according to the present invention.

[BRIEF EXPLANATION OF THE DRAWINGS]

[Fig.1]

A perspective view of a club head showing an embodiment of the present invention.

[Fig.2]

An exploded view thereof.

[Fig.3]

A front view of a club head under the standard state showing an embodiment of the present invention.

[Fig.4]

(A) is a cross sectional view taken along line A-A of Fig.3.

(B) is an enlarged view showing B region thereof.

[Fig.5]

A perspective view of a club head for explaining the face peripheral edge part and head main body front edge region.

[Fig.6]

(A) is a plan view of a club head under the standard state.

(B) is the C-C cross section thereof.

[Fig.7]

(A) is a front view of a club head.

(B) is a cross sectional view taken along a plane E1, E2 ---.

[Fig.8]

A side view for explaining the measuring method in the vibration method.

[Fig.9]

A front view of a club face.

[Fig.10]

A whole block diagram for explaining the vibration method.

[Fig.11]

A graph showing a frequency transfer function.

[Fig.12]

A graph showing the relationship between the coefficient of restitution and face rigidity ratio.

[Fig.13]

A graph showing the relationship between the coefficient of restitution and the primary frequency of the club head.

[EXPLANATION OF THE REFERENCE]

- 1 Golf club head
- 2 Face portion
- 2P Face member
- 3 Head main body portion
- 3P Head main body portion member

3a Crown portion
 3b Sole portion
 3c Side portion
 3d Neck
 4 Head main body front edge region
 5 Face peripheral edge part
 h Shaft inserting hole
 CL Center line of shaft inserting hole
 F Club face

Translations of the drawings

Fig.9

[toe side] [heel side]

Fig.10

[Power unit] [FFT analyzer] [Record]
 [vibrator]
 [Power amplifier]

Fig.11

Ordinate: Frequency transfer function (dB)

Abscissa: Frequency (Hz)

Fig.12

Ordinate: Coefficient of restitution

Abscissa: Face rigidity ratio

Fig.13

Ordinate: Coefficient of restitution

Abscissa: Frequency (Hz) of primary local minimum of frequency
 transfer function

[Document name] Abstract

[Abstract]

[Problems]

To improve the rebound performance while increasing the sized.

[Solution]

It is a hollow golf club head 1 having a head volume of not less than 450(mm³). It is composed of a face portion 2 and a head main body portion 3 of which front edge is connected to the back face of the face portion 2 and which forms a club head rear part. The height of the club face is 55 to 85(mm), and the area of the club face is 4000 to 6500(mm²). The ratio (Rf/Rh) of the face rigidity Rh defined by the following expression①, of the head main body front edge region 4 defined as extending for 10mm length rearwards of the club head from the front edge of the head main body portion 3, and the face rigidity Rf defined by the following expression ②, of the face peripheral edge part 5 which is an annular zone apart from the peripheral edge E of the club face F towards the center of the club face by not less than 3mm but not more than 15mm is 4.0 to 12.0.

$$R_h = E_h \cdot t_h^3 / 12 \cdots \textcircled{1},$$

$$R_f = E_f \cdot t_f^3 / 12 \cdots \textcircled{2}$$

wherein E_h is the Young's modulus of the head main body front edge region, E_f is the Young's modulus of the face peripheral edge part, t_h is the average thickness of the head main body front edge region, and t_f is the average thickness of the face peripheral edge part.

[Figure selected] Fig.1